Chapter 6

VIRTUAL REALITY EXPOSURE THERAPY OF COMBAT-RELATED PTSD: A CASE STUDY USING PSYCHOPHYSIOLOGICAL INDICATORS OF OUTCOME

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INTRODUCTION

Posttraumatic stress disorder (PTSD) is a pervasive and chronic disorder in veterans of the Vietnam War (Kulka, et al., 1990; Weiss et al., 1992). Although research has demonstrated the effectiveness of cognitive-behavioral treatments in reducing symptoms of PTSD in veterans (e.g., Keane, Fairbanks, Caddell, & Zimmering, 1989a), many veterans remain untreated or are unresponsive to treatment (Kulka et al., 1990). Treatment is generally time intensive and demanding, especially exposure therapy, which requires considerable therapist expertise and resources. Participants are generally not thought to be good candidates for exposure ther-

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apy if they fail to imagine vividly their painful memories of combat or if they avoid processing their feelings to a sufficient degree.

Virtual reality is a relatively new medium for exposure therapy. It integrates real-time computer graphics, body-tracking devices, visual displays, and other sensory input devices to immerse a participant in a computer-generated virtual environment. Virtual reality exposure (VRE) therapy may be more advantageous than other exposure treatments (e.g., imaginal exposure) since it may require fewer therapist resources and may be a more efficient vehicle to meet the necessary conditions of therapeutic emotional processing of traumatic memories (Rothbaum et al., 1999). Preliminary studies using VRE in the treatment of phobias have shown promising effects for this mode of treatment (Carlin, Hoffman, & Weghorst, 1997; Rothbaum et al., 1995; Rothbaum, Hodges, Smith, Lee, & Price, 2000) as well as lasting effects of treatment (Rothbaum, Hodges, Anderson, Price, & Smith, 2002).

Rothbaum and colleagues (1999) recently demonstrated the efficacy of VRE in the treatment of a Vietnam veteran suffering from PTSD. Their findings indicated that the participant showed clinically significant reductions in PTSD, anxiety, and depressive symptomatology following virtual reality exposure treatment. These results were replicated in an open clinical trial with Vietnam veterans, finding significant symptoms reductions with treatment that lasted following treatment termination (Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001).

The purpose of this single case study was to replicate Rothbaum et al.'s (1999) findings, namely, to examine the efficacy of VRE therapy in the treatment of a Vietnam veteran with chronic PTSD symptomatology. As in Rothbaum et al.'s (1999, 2001) studies, standardized interview and self-report measures of psychiatric symptomatology and functioning were used. However, this study is unique in that psychophysiological responses were measured throughout the treatment. While all prior studies of VRE therapy relied on patients' report of outcome and process, which are subject to bias and demand, psychophysiological assessment provides an objective indicator of outcome and an online index of emotional processing *during* the VRE sessions. In addition, the psychophysiological procedure provides a vehicle to evaluate whether negative affect and arousal are attenuated within session which would indicate extinction of the conditioned emotional response. Although it is assumed that the principal change agent in exposure therapy is extinction, within-session extinction is rarely achieved (e.g., Boudewyns & Hyer, 1990) and measurement of psychophysiological process across sessions may inform the mechanisms of change.

The participant of this case report is a veteran who experienced severe guilt and shame about acts of unnecessary violence in the warzone. Although we may never know the extent to which veterans with chronic PTSD suffer from guilt about acts of omission or commission of violence in the warzone, clinicians who treat veterans tend to agree that these experiences are difficult to address in treatment, and may be one of the causes of chronicity (e.g., Kubany, 1997). Furthermore, exposure therapy is typically seen as contraindicated for sufferers of PTSD who also perpetrated acts of unnecessary violence in the warzone and present with severe guilt and shame. The argument is that if patients feel guilt, these feelings will only be intensified from their narrative accounts of acts of perpetration, and guilt and shame are assumed to be emotions that fail to attenuate upon repeated exposure (Pitman et al., 1991). However, this loose heuristic is based on a commonly held view of exposure therapy as a fear extinction–based procedure exclusively. More recently, it has been suggested that an additional mechanism of change in exposure therapy is the re-appraisal and reconstruction of the meaning of a traumatic event, especially in important dimensions of the self-schema (Cason, Resick, & Weaver, 2002). In this framework, a veteran who describes, in vivid detail, the causes of an act of perpetration, the act itself, his emotional responses at the time, and the meaning he attributes to the events, lays the groundwork for belief change. This case study examines the efficacy of this process in treating PTSD-related guilt and shame.

METHOD

Participant

The participant was a 52-year-old, married Caucasian male Vietnam veteran who had served as a mortarman for 13 months in Vietnam during 1967–68 and was seeking clinical services at the National Center for PTSD in Boston. Unlike the modal Vietnam veteran seeking services at the center, the participant was not seeking financial compensation for war trauma and PTSD. His presenting complaints were extreme anxiety, depression, intrusive thoughts, and nightmares. Although he received some psychiatric services in the early 1970s, he had never been in therapy or received treatment specifically for PTSD. The participant reported experiencing a recent exacerbation of a long history of PTSD symptoms as a result of reuniting with some of his comrades from the war.

At the time of the study, the participant was in a stable marriage of 23 years, residing with his wife and one of four children. The participant was a practicing Catholic, and his religion was an important source of coping and comfort to him. He had a severe alcohol and drug dependence history, which impaired his relationships and his capacity to work. Nevertheless, he managed to retain a steady job for 30 years, and had been sober of alcohol for the last 20 years. He had a lengthy history of marijuana abuse, which he reported helped him calm down and "relive Vietnam experiences," in order to imagine he could control them and change the outcome. He reported an intensification of his PTSD symptoms, anxiety, and anger since he stopped his marijuana use in 1999.

The participant's experiences in Vietnam left him with very chronic and severe guilt about acts of commission and shame about transgression. He reported a chronic history of bouts of anger interspersed with severe anxiety and other negative affect. When upset, he reported being "jittery" and "shaking with rage." Typically, the participant would cope with his guilt and shame by externalizing, blaming, and expressing rage at the Vietcong. As would be expected, the veteran struggled with depression chronically and was hospitalized in the early 1970s for depression and suicidality.

While in the warzone, the participant reported the following events as the most distressing.

Traumatic event 1: One of the most distressing events for the participant occurred on the day he learned his close friend had been killed in action. Feeling helpless, angry, and overwhelmed by the news, the participant deliberately fired one mortar blindly into a nearby village. The following day, he learned that someone had been seriously injured as a result of the attack. The participant reported that he felt no remorse at the time of the event, but that he now feels deep guilt about what he did.

Traumatic event 2. Another very distressing event occurred when the participant and his comrades entered a village and came upon the mutilated body of a young girl. They soon realized that this was a trap, and they were ambushed. Soon after, he was horrified to witness a sergeant ordering the demolition of a village hut that held ammunition, despite knowing that civilians had taken shelter there.

Traumatic event 3. The participant described witnessing one of his own men being hit by friendly fire. He stated that the man "disintegrated before my eyes."

Traumatic event 4. Another particularly distressing event, which the participant described, was an entire day of battle, which began by a surprise attack by the North Vietnamese. He reported that his company had incurred many casualties, and one of his close friends had been wounded. During this battle, the veteran stated that he was filled with anger and anxiety, and he had "lost it," taking revenge on the North Vietnamese.

Traumatic event 5. After being ambushed by the North Vietnamese, the participant described the "shocking" experience of having to walk through bodies of wounded fellow soldiers.

Procedure

The participant described in this report was part of a larger research study. In that study, an independent assessor administered a standardized pretreatment evaluation consisting of clinical interviews and self-report measures to potential subjects. Participants had to currently meet PTSD diagnostic criteria to be included in the study, and participants were allowed to continue any concurrent psychosocial treatments during the course of the study. Exclusion criteria were as follows: A documented history or current clinical evidence of mania, schizophrenia, psychosis, or organic mental disorders; unstable medication conditions; prominent suicidal ideation; current alcohol or drug abuse/dependence; and panic disorder or any other physical or emotional problem that would interfere with wearing the virtual reality helmet. If the potential participant met the eligibility criteria, he was provided information about the study and asked to sign an informed consent.

The participant in this study failed to meet the formal diagnostic criteria for PTSD, using the "1–2" DSM–IV decision rule* on the Clinician-Administered PTSD Scale (CAPS; Blake et al., 1995) by only one criterion C symptom (avoidance and numbing symptoms). Rather than avoiding Vietnam-related cues, the participant reported a history of approaching these cues in attempts to gain mastery, to make sense out of what happened to him, and to change the outcome. Despite his subthreshold PTSD symptomatology according to the CAPS, a consensus judgment was made to include this participant in the study based on the following information: (a) The veteran met or exceeded the diagnostic threshold on the

*A frequency of "1" or higher and an intensity of "2" or higher for a given item indicates symptom endorsement.

two paper-and-pencil measures of PTSD: PTSD Checklist (PCL; Weathers, Lit, Hermann, Huska, & Keane, 1993) and the Mississippi Scale (Keane, Caddell, & Taylor, 1988). (b) The participant's wife completed a collateral version of the Mississippi Scale (Niles, Herman, Segura-Schultz, Joaquim, & Litz, 1993; Taft, King, King, Leskin, & Riggs, 1999), and reported that the participant experienced severe symptoms (total score of 123 out of 195). (c) The independent evaluator described the participant as having a very exacting and concrete reporting style, rather than the global overendorsing style, which often characterizes veterans seeking compensation. In addition, he had avoided seeking treatment for many years, because he thought, "I should be able to handle it myself," and he experienced significant shame about seeking treatment. As a result, he may have minimized his presentation to the evaluator. (d) In the interview, the veteran endorsed severe and specific re-experiencing symptoms and was emotive and reactive in moments of sharing his trauma, which suggested that he would be a good candidate for exposure therapy.

Instruments

Standardized psychometric measures of PTSD and comorbid psychopathology were used to assess change across time. Assessments were administered pre- and posttreatment, and at follow-ups of 3 and 6 months posttreatment to explore treatment effects. The assessments consisted of the following measures: CAPS (Blake et al., 1995); PCL (Weathers et al., 1993); psychotic screen module from the Structured Clinical Interview for DSM–IV (SCID; First, Spitzer, Gibbon, & Williams, 1995); Beck Depression Inventory (BDI; Beck, Ward, Mendelsohn, Mock, & Erbaugh, 1961); Brief Symptom Inventory (BSI; Derogatis, 1993); Combat Exposure Scale (CES; Keane et al., 1989b); Mississippi Scale (Keane et al., 1988); Boston Life Satisfaction Inventory (Smith, Niles, King, & King, 2001).

In addition, the participant also participated in an assessment of psychophysiological reactivity at pre- and posttreatment, using a script-driven imagery procedure (see Keane et al., 1998). More specifically, psychophysiological responses were measured while the participant listened to 30-second taped descriptions of two of his combat traumas (events 1 and 2 described above), interspersed with two neutral scripts (e.g., sitting on the beach); he was instructed to imagine each of these scenes as vividly as possible while listening to each script.

Psychophysiological reactivity during the virtual Vietnam environments was also measured to examine the process of change within and between sessions. Psychophysiological data was collected for heart rate (HR) and skin conductance (SC). HR activity was recorded from 9-mm-diameter SensorMedics Ag-AgCl electrodes (SensorMedics, Yorba Linda, CA) filled with Beckman electrolyte and attached by adhesive collars at standard lead I (arm) sites. Electrodes were connected to a Coulbourn Instruments high gain bioamplifier (S75-01, Coulbourn Instruments, Allentown, PA), and output from the amplifier was directed to a Coulbourn Instruments tachometer (S77-26) to yield a beats-per-minute (BPM) equivalent of each interbeat interval. SC was recorded from adjacent sites on the hypothenar eminence of the nondominant hand using 1-cm Beckman Ag/AgCl electrodes filled with Unibase-saline paste (Lykken & Venables, 1971) and connected to a Coulbourn-isolated SC coupler (S71-23). Digital sampling (20 Hz) of data occurred twice a second in 60-second blocks (i.e., trials); trials were initiated by a button press by experimenter. Prior to each recording session, the SC coupler was calibrated to register activity from 0 to 40 Siemens. Digitized measurements (A-D units) were converted to conductance values (uSiemens) using the appropriate calibration parameters.

For each VRE session, psychophysiological data was collected at minute 5 of the 5-minute pre-baseline period (i.e., neutral virtual environment), minutes 1 and 25 of the virtual Vietnam environment, and minute 5 of the post-baseline period (i.e., neutral virtual environment). In addition, data were collected during moments selected by the experimenter, which seemed particularly evocative in the virtual Vietnam environment. Thus, on average, each VRE session consisted of approximately 25 one-minute trials of psychophysiological data.

Treatment

In the therapy phase, the participant was treated twice per week over a 5-week period. During the VRE sessions the participant wore a head-mounted display with stereo earphones that provided visual and audio cues consistent with being near, outside, and inside a Huey helicopter (refer to Rothbaum et al., 1999, for a more extensive description of the VRE apparatus). The therapist asked the participant to give a Subjective Units of Distress (SUDS) rating approximately every 5 minutes during all exposures as an indication of his level of anxiety. The therapist made comments

and encouraged the patient to sustain his focus on critical elements of a traumatic memory and negative affect in the service of maximizing exposure and facilitating extinction. The participant was allowed to progress at his own pace. The therapist simultaneously viewed on a video monitor the virtual environment in which the participant was interacting, and therefore was able to comment appropriately.

Two different virtual Vietnam scenarios were used. In the virtual landing zone (jungle clearing), the participant stood on a platform, which had a woofer underneath to provide vibrations. He used a joystick to give the illusion of walking forward and backward in the virtual environment. Audio effects included recordings of jungle sounds (e.g., crickets), gunfire, helicopters, mine explosions, and men yelling, "Move out! Move out!" which could be increased in intensity. Visual effects included muzzle flashes from the jungle, helicopters flying overhead, landing and taking off, and fog.

In the virtual helicopter, audio effects included the sound of the rotors, gunfire, bombs, B52s, engine sounds, radio chatter, and men yelling various commands. Visual effects included the interior of a Huey helicopter in which the backs of the pilot's and copilot's heads with patches were visible, instruments, controls, as well as the view out of the helicopter side door. This view included aerial shots of other helicopters flying by, clouds, and the terrain below, which consisted of rice paddies, jungle, and a river. To increase the effectiveness of the illusion of actually being in a helicopter, the participant sat in a chair that had a woofer under the seat that provided vibrations.

Treatment proceeded in an additive manner. During session 1, the participant was made familiar with the treatment procedures. He was able to try on the virtual reality helmet and explore a neutral virtual environment, namely a room with a few pieces of furniture. The therapist reviewed his five most traumatic combat memories, obtained in the diagnostic session, and determined a hierarchy of traumatic events based on the participant's level of distress (i.e., SUDS rating) evoked by the particular memory. Finally, he was instructed in breathing retraining, a relaxation technique frequently used in exposure therapy (Rothbaum et al., 1999).

During session 2, the participant was exposed to the virtual landing zone, and he was encouraged to explore it. Virtual effects were added gradually, as he was able to tolerate them. The participant spent 30 to 45 minutes of this and all remaining therapy sessions with the helmet on: 5 minutes in the neutral environment, then 20 to 35 minutes in the "virtual

Vietnam," then the last 5 minutes back in the neutral environment. The remainder of each 90-minute session was spent on an initial check-in, attachment and detachment of physiological sensors, postexposure breathing retraining, and debriefing. Session 3 was similar to session 2, but in this session the participant was exposed to the Huey helicopter virtual environment.

In sessions 4 and 5, VRE therapy continued, but the participant was asked to share any memories that were triggered by the virtual environment. He described each memory in the present tense with his eyes open to view the virtual environment. The therapist attempted to match the virtual stimuli to the participant's description of his traumatic experiences.

From sessions 6 to 10, the participant was asked to recount his most traumatic memories, which were discussed in session 1. The therapist had the participant focus on one memory at a time, beginning with the least traumatic in the hierarchy and gradually proceeding to more difficult memories. The participant was encouraged to focus his attention on the memory and any negative affect elicited. These sessions were audiotaped, and the tapes were given to the participant to practice imaginal exposure as daily homework. At the end of each VRE session, the therapist debriefed the participant for at least 15 minutes. These conversations were deemed to be a critical aspect to the VRE therapy. The therapist asked the participant to share what it was like to disclose the trauma and to share his feelings and the meaning of the experience. These conversations were poignant for both the therapist and the participant and resulted in an examination of beliefs and constructions, which over time were less maladaptive. All sessions were videotaped to ensure adherence to treatment protocol.

RESULTS AND DISCUSSION

Psychometric Measures

The participant reported considerable change in PTSD symptoms at posttreatment and the two follow-up intervals as seen in Table 6.1. Most noteworthy is the change in the two categories of PTSD symptoms referenced to the targets of the VRE treatment, namely reexperiencing symptoms (all Category B symptoms) and the two strategic avoidance symptoms (Categories C-1 & C-2). Immediately posttreatment, the participant's

Table 6.1 Self-Report Measures

Measure	Pre	Mid	Post	3-month	6-month
CAPS—Total Score	40	—	49	49	30
reexperiencing (B symptoms)	21	—	18	13	2
avoidance (C1 & C2)	0	10	0	5	
arousal (D symptoms)	12	—	11	18	16
PCL	48	42	38	34	41
BSI—Global Severity Index	1.12	—	—	0.83	0.81
BDI	16	14	10	13	10
BAI	16	—	16	13	13
Mississippi Scale	107	—	99	96	100
Boston Life Satisfaction Inventory	103	—	135	131	134
Combat Exposure Scale	28	—	—	—	—

Note. CAPS = Clinician Administered PTSD Scale; PCL = PTSD Checklist; BSI = Brief Symptom Inventory; BDI = Beck Depression Inventory; BAI = Beck Anxiety Inventory.

reexperiencing symptoms showed only a slight decrease compared to their pretreatment baseline values. This is consistent with the therapist's observation that at the end of the 5 weeks of treatment, the participant was still grappling with new ways of construing the traumatic events processed during the VRE procedure.

During and immediately after the VRE treatment, the veteran was attempting to reconcile being a young victim of the horrors of the Vietnam War who tried his best to survive the experience, and being a perpetrator of violence. However, at the end of treatment the veteran was no longer vacillating severely between cognitive assimilation of his acts of brutality in the war, by indignantly expressing rage and dehumanizing the enemy, and excessive overaccommodation of the meaning or implication of the acts of perpetration. The latter entailed absorbing too much blame and experiencing despair from guilt about responsibility for others' suffering. The veteran was nevertheless still raw and quite sensitive and continued to have some reexperiencing symptoms immediately posttreatment as he continued to process his trauma memories. Over the course of the 3-month and 6-month follow-ups, however, he reported a dramatic decrease in reexperiencing symptoms.

In terms of the participant's posttreatment increases in strategic avoidance symptoms, this was the result of a noteworthy shift in coping strategy. Prior to treatment, the participant reported no avoidance of thoughts and feelings related to his trauma and no avoidance of situations that

trigger recall of the trauma, which is highly unusual given the extent of his exposure to combat trauma. The veteran would seek out reminders of Vietnam combat (e.g., regularly viewing his medals) and feel as much as he could, particularly anger and rage, and sadness and guilt, which was in the service of contrition and shame. At the end of the 5 weeks of therapy, the participant ostensibly learned to be more strategic in avoiding reminders and feelings related to the trauma. This was seen as a step in the trajectory of change of these behaviors, which, as can been seen in Table 6.1, were reduced considerably over time.

Overall, the participant reported very significant gains, which were maintained at the 6-month assessment interval. At this last assessment, his CAPS total score as well as his reexperiencing and strategic avoidance symptoms were reportedly low. Furthermore, his life satisfaction had increased. However, there were a variety of life stressors and demands (e.g., an increase in job stress, family conflicts) that may have served to maintain a degree of stress symptoms (as indexed by Criterion D PTSD symptoms and BSI Global Severity Index) as well as mild anxiety (indexed by the BAI) and depression (as indexed by the BDI), at all assessment intervals. This is not unusual, particularly given that the exposure therapies such as VRE are primarily designed to target reexperiencing symptoms and strategic avoidance behaviors as opposed to stress management and problem-solving approaches to PTSD treatment that attempt to address stress symptoms more broadly.

In terms of the participant's guilt and shame about acts of perpetration of unnecessary violence in the war zone, the patient made considerable gains. At the outset of treatment, the participant expressed that he periodically saw himself as a War criminal who should go to prison for his actions in the warzone, and at other times he would completely blame the enemy. He could see himself as a young man who experienced loss, but he did not know how to cope with the loss or he refused to take responsibility for his actions and forgive himself. At the outset of the VRE procedure the participant was unable to think about the victim of his retaliatory rage without becoming enraged at the Vietnamese or being consumed by self-blame. At the end of treatment, the participant expressed concern about his victim and could appreciate her humanity and would brainstorm spontaneously about ways to help victims of war. At the end of treatment, the participant could also focus on the sadness he felt about his lost comrade (the event that provoked the retaliatory rage) and could acknowledge that he too was victimized generally as a young soldier.

Physiological responsivity across sessions

Figures 6.1 and 6.2 show the participant's heart rate and skin conductance reactivity, respectively, across each VRE session. For each treatment session, values are provided for the pre- and post-baseline periods in which the participant was in the neutral virtual reality environment. The graphs also include mean values for the first, highest, and last 1-minute trials of data collection during the virtual Vietnam environment for each session. Figure 6.3 provides a graph of the participant's SUDS ratings across each treatment session, and Figure 6.4 shows mean heart rate.

In general, the participant appeared to be physiologically reactive in the first VRE session, when he was exposed to the virtual landing zone. However, his response levels dropped for session 3, when he rode in the helicopter. As it turned out, the participant did ride in helicopters in Vietnam, but they were not a particular source of trauma for him, so this virtual scenario was not used again. As seen in Figure 6.1, his peak responses were relatively high for sessions 4 and 5, when he began to explore actual memories of combat that were triggered by the virtual environment. Notably, in session 5, the virtual Vietnam environment had triggered memories about an enemy attack and the battle that followed,

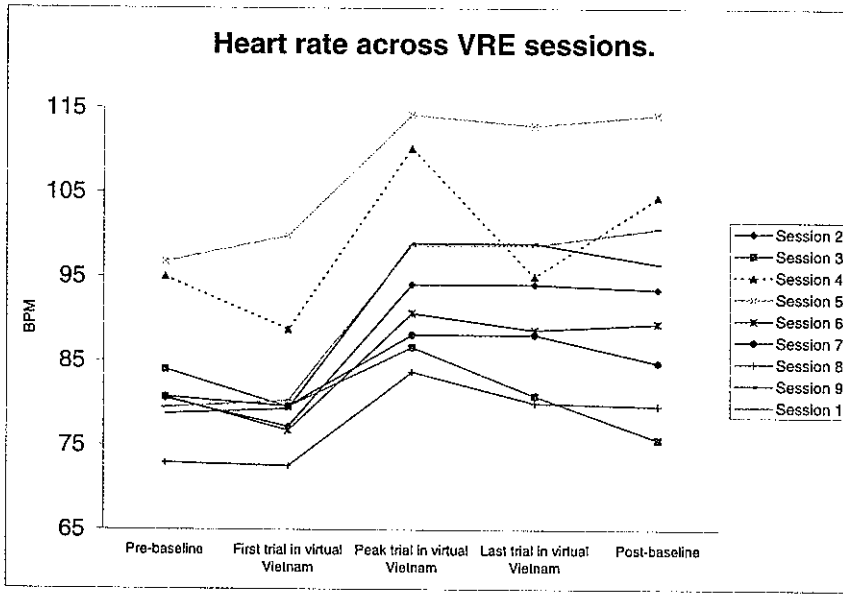

Figure 6.1 Heart Rate Across VRE Sessions

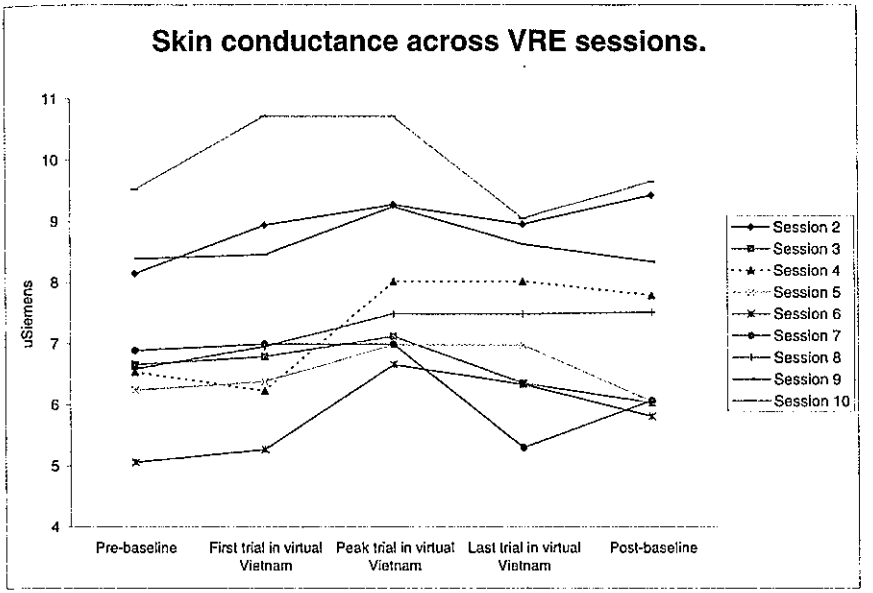

Figure 6.2 Skin Conductance Across VRE Sessions

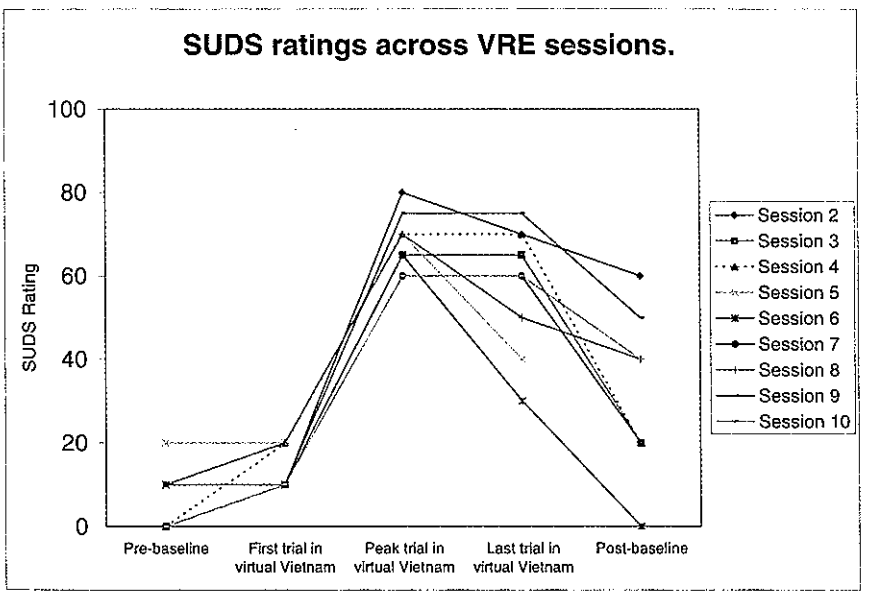

Figure 6.3 SUDS Ratings Across VRE Sessions

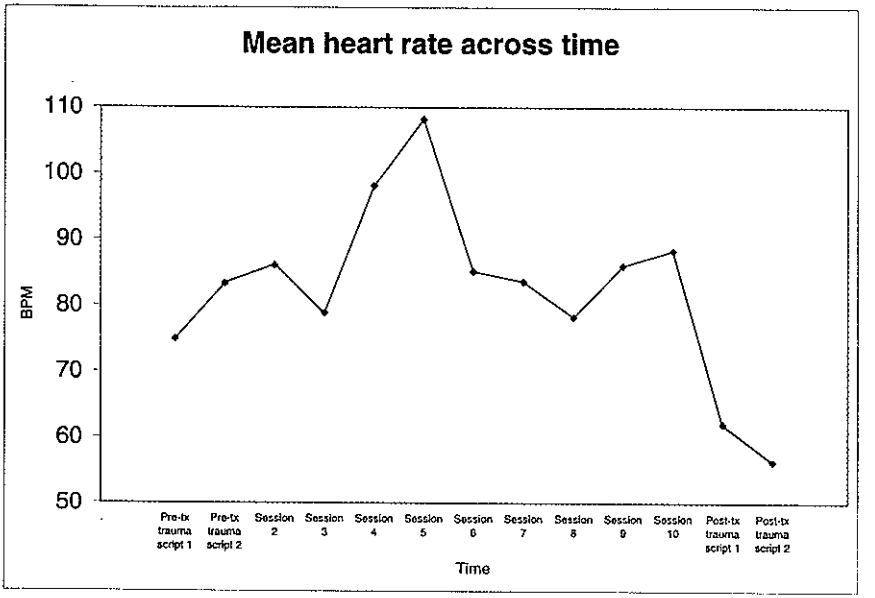

Figure 6.4 Mean heart rate across time.

which the participant reported he had forgotten until then. The participant was very emotionally engaged in reliving these experiences. As expected, the other highest values in Figures 6.1 and 6.2 occurred in sessions 9 and 10 when the participant explored his most traumatic memories, which were of his most severe battle (see event 4 on pg 7).

The psychophysiological data and SUDS ratings collected within the VRE sessions are suggestive of three main findings. First, the participant's physiological reactivity to the virtual Vietnam stimuli indicated significant emotional processing, which is a necessary ingredient to exposure therapy. Compared with his baseline values in the neutral environment, the participant showed a substantial increase in responsivity when exposed to the virtual Vietnam environment. For example, as seen in Figure 6.1, during the participant's most intense session (i.e., session 5), his HR reached a peak of 114 BPM, which was a significant increase from his pre-baseline HR of 97 BPM. Moreover, as Figure 6.2 indicates, the participant's SC also showed substantial increases within the VRE sessions compared with his baseline values.

Second, although there were signs of within-session extinction of conditioned responses to trauma cues in some sessions, more often than not, the

participant maintained a high level of physiological activity at the end of the session. In contrast, in nearly all the sessions, as can be seen in Figure 6.3, the participant reported reduced SUDS ratings at the end of the session, which suggests extinction of conditioned response to trauma memories. It is unclear why there was a disconnect between the SUDS ratings and the physiological indicators of emotional behavior despite that these are always only moderately correlated (e.g., Keane et al., 1998). It may be that the SUDS ratings were in part influenced by a demand effect, or it may be that this participant was not sufficiently in-tune with his bodily response to trauma cues. In any case, the data suggests that a diminution of reaction to trauma memory processing during the VRE was not the sole change agent.

It should be noted that at the end of every session, the therapist would spend at least 15 minutes carefully discussing the participant's experience, which in every instance appeared to lead to a reduction in tension and negative affect. Thus, it may be that in exposure therapy, residual hyperarousal can be redressed by systematically allowing patients time at the end of a session to decompress and process their experiences. This should not be underestimated as a possible change agent in exposure therapy with Vietnam veterans and follows the recommendations for exposure therapy (Foa & Rothbaum, 1998).

Third, it appears that there was some decrease in physiological responsivity over the course of treatment. During the first VRE session (session 2), the participant was exposed to very few trauma cues, but nonetheless, his reaction was quite strong. For instance, his heart rate reached 94 BPM, up from 77 BPM when he first entered the virtual landing zone, and his SUDS ratings reached a peak value of 80. Comparing this with the participant's last two sessions, when he was repeatedly going over his worst combat trauma, an ambush and brutal firefight with many casualties, his heart rate reached a maximum of 99 BPM which is not much higher than when he was simply exploring the virtual Vietnam environment in session 2, despite the fact that in the last two treatment sessions, he was experiencing a virtual battle. Furthermore, his SUDS ratings peaked at 75 in session 9, which is lower than his SUDS ratings during the first, relatively benign VRE session.

Physiological Assessment Pre- and Posttreatment

As can be seen in Table 6.2, the participant's resting pretreatment heart rate was discrepant with his post-assessment baseline as well as his pre-

Table 6.2 Psychophysiological Data at Pre- and Post-Treatment While Listening to Idiographic Trauma Scripts

	Pre-treatment				Post-treatment			
Parameter	Baseline	Trauma	Trauma Script 1	Post-Script 2	Baseline baseline	Trauma Script 1	Trauma Script 2	Post-baseline
Heart rate (beats/min)	74.09	74.90	83.30	58.65	58.30	62.02	56.33	58.88
Skin conductance (μSiemens)	6.53	7.29	8.17	6.99	7.92	8.64	7.25	8.73
Systolic blood pressure (μm)	137	142	153	—	133	134	129	129
Diastolic blood pressure (mm)	84	88	92	—	82	90	89	90

and post-baseline during the posttreatment assessment, suggesting that the participant initially experienced anticipatory anxiety about the laboratory procedure, which is quite common (e.g., Keane et al., 1998). Thus, it appears that the participant's "true" baseline heart rate was approximately 58 BPM, which is consistent with his degree of aerobic fitness. Using 58 BPM as the baseline index, the participant exhibited severe increases in cardiac activity in response to both trauma-scripts (event 1 and event 2, respectively; see previous). In contrast, the participant's posttreatment cardiac reactivity was equivocal relative to his baseline. Table 6.2 also shows that there was an 8-point drop in systolic blood pressure from pre- to posttreatment for the first trauma script, and a 24-point drop for the second trauma script. However, diastolic blood pressure did not change substantially, which is not unexpected, since systolic blood pressure is known to be more sensitive to phasic stress responses compared to diastolic blood pressure (Llabre, Spitzer, Saab, & Scheiderman, 2001).

The participant's skin conductance responses did not match up well with his cardiovascular response at the pre- and posttreatment assessments (see Table 6.2). The skin conductance values were uniformly very high suggesting a ceiling effect [the mean skin conductance values in a large study of veterans was 3.8 (*SD*=3.6); Keane et al., 1998]. In any event, it appears that this particular participant was a cardiovascular reactor more than any other channel of response. Nevertheless, the participant did show modest reactivity to trauma scripts at the pretreatment assessment, and a slight decrease in reactivity at posttreatment relative to his baseline. These results, taken as a whole, strongly suggest that at the end of VRE, the participant was substantially less physiologically reactive to two key trauma memories compared with his pretreatment assessment.

CONCLUSION

We have described the treatment of a Vietnam veteran for PTSD related to his war experiences by virtual reality exposure therapy. Psychophysiological monitoring occurred throughout the treatment as well as at pre- and posttreatment. Although the treatment was considered successful, that would not be clearly evident by the usual standards. His scores on standardized measures of PTSD and related symptoms decreased, but in many cases not until 6 months after the termination of therapy. Much of his distress was triggered by acts committed by him or with his participation

in Vietnam and he responded with guilt and anger. In many ways, the most important aspects of his therapy occurred in each session *after* the exposure therapy when the material was discussed in a more cognitive therapy type of discussion. We have found this processing of the traumatic material that comes up in exposure therapy not just useful, but mandatory, for effective emotional processing.

Regarding his physiological responding to the virtual Vietnam stimuli, there were clear signs of significant emotional engagement, although, more often than not, the participant maintained a high level of physiological activity at the end of the session. Consistent with this finding, we have found in conducting exposure therapy with sexual assault survivors with PTSD that the between-session habituation is more important than the within-session habituation (Jaycox, Foa, & Morral, 1998). It is also interesting that his physiological reactivity did not always match his self-report of distress. Despite these difficulties and inconsistencies, the patient did well in therapy. We chose this case to highlight some of the interesting aspects of exposure therapy, virtual reality exposure therapy, and psychophysiological monitoring.

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